Air Quality

Teacher's Introduction to Air Quality

Air Quality Improvements Made, But Complex Problems Still Face the State

Kentucky's air quality is affected by many different factors including more than 3,000 industrial air pollution sources, smaller but significant sources such as automobiles, and the weather. Many of our air quality problems are directly linked to the burning of fossil fuels (coal and petroleum) for energy. This energy is used for transportation, and in our homes and businesses.

Most of Kentucky meets the national air quality standards for lead, sulfur dioxide, nitrogen oxides, carbon monoxide, airborne particles, and ground level ozone or smog, which were established to protect public health. During the last 20 years, strategies to control air pollution have been fairly successful in reducing the level of these pollutants in the air.

Pollution controls required for industry, business, and vehicles have greatly reduced the average concentration of many of the pollutants in our air. For example, the average level of lead in the air has decreased more than 90% in several regions of the state due to the phase-out of leaded gasoline. The most notable exception is ground level ozone which is still a problem in several Kentucky counties and in a number of urban areas in the United States.

Today, relatively new and more complex air quality issues such as acid rain, ozone depletion, global warming, and air toxics face our state, nation, and planet. The following activities will involve students in assessing these real world problems while sharpening their math, science, and writing skills.

ν Where to Get Information

The "State of Kentucky's Environment" report provides regional air quality data for various pollutants, information about industrial air toxics, an overview of acid rain, global warming, ozone depletion, and radon gas problems. Check the index in the report for general information and the expanded index in the Appendix of this guide to find a list of all the references to your county and region.

ϖβ Overview of Student Activities

Activity 1: Understanding Air Pollution

This activity provides a general understanding of air quality problems both statewide and in various regions of Kentucky. Students will work in groups to review charts and graphs that depict trends in air pollution and consider how they might contribute to the problems and solutions.

Activity 2: Measuring Your Air Quality

In this activity students will have an opportunity to monitor air quality in Kentucky by tracking the "Air Pollution Index" and other information on datasheets.

Activity 3: Acid Rain in Kentucky

Students will review acid rain problems in Kentucky and investigate the pollutants linked to its formation. Students will also track the acidity of the rainfall in their community, compare the data to statewide trends, and draw conclusions about the problem.

Activity 4: Global Warming and Ozone Depletion: Defining Your Role in the Problem

This activity provides an analysis of each individual's contribution to the problem of global warming and their role in reducing this threat. Students will also investigate the chemicals associated with the depletion of the Earth's protective ozone layer.

Activity 5: Radon Gas: The Hidden Risk

In this activity students will assess one of the state's most serious health risks, radon gas, by investigating the results of monitoring projects statewide and in their region. Students will be offered an opportunity to evaluate radon gas problems in their homes and school.

Activity 1. Understanding Air Pollution
Instruction Sheet

DO YOU KNOW..
- Why lead levels in Kentucky's air have declined 90% during the past decade?
- If the air is safe to breathe in your community?
- How energy use can impact air quality?

Progress Made in Cleaning Up Air Pollution

Air quality in Kentucky has improved dramatically during the past 20 years. State and federal governments' efforts to clean up our air have focused on several air pollutants including ground-level ozone (smog), lead, sulfur dioxide, nitrogen oxides, carbon monoxide, and airborne particles.

Although efforts to control the release of pollutants from industries, vehicles, and other sources, have improved our air quality, new and more complex air quality problems such as global warming, acid rain, and industrial air toxic releases confront us today. The Clean Air Act Amendments passed by Congress in 1990 require federal and state government agencies to seek ways to address these more difficult problems.

The diverse nature of air pollution and its many sources makes controlling it a challenge. Many accomplishments have already been made, but we have a long way to go before our air is considered clean.

Purpose:
This activity provides a general understanding of air pollution statewide and in your region. You will work in groups to review charts and graphs that depict air quality trends and consider how you might contribute to the problems and solutions.

Procedure:
Part 1 - Analyzing Your Air Quality

1. Obtain Worksheet #1 from your teacher and review the first page. As a class, use Figure 1 to identify the "air quality control region" (AQCR) in which your community lies. This will allow you to analyze information contained in Worksheet #1 regarding your local air quality because much of the data is tracked and reported as regional averages. (Note: Monitoring data is not available for some regions for certain pollutants. You can study the region closest to your region or of interest to you if data is unavailable for your region.)
2. Divide into three groups A-C. Each group will research the following air pollutants:
   - Group A: Ozone
   - Group B: Carbon Monoxide, Lead, and Particulate Matter
   - Group C: Nitrogen Oxides and Sulfur Dioxide
3. Analyze the text and charts/graphs in Worksheet #1 for the pollutants assigned to your group and summarize the following:
   1. How this pollutant affects you.
   2. Trends in levels of this pollutant in your air quality control region, or a region of interest to you. Is air quality getting better, worse, or staying the same with regard to each pollutant? Why?
   3. How your activities may contribute to releases of this air pollutant.
4. Present your group's findings to the class.

Part II - Comparing Your Air Quality to Other Regions of the State

1. Prepare a report regarding the air quality problems in Kentucky based on the group presentations and your review of Worksheet #1. Include in the report a summary of the air quality in your region compared to other regions of the state. Explain why you think air quality varies within the different regions. Also discuss whether you think air quality will improve or get worse in Kentucky and why.

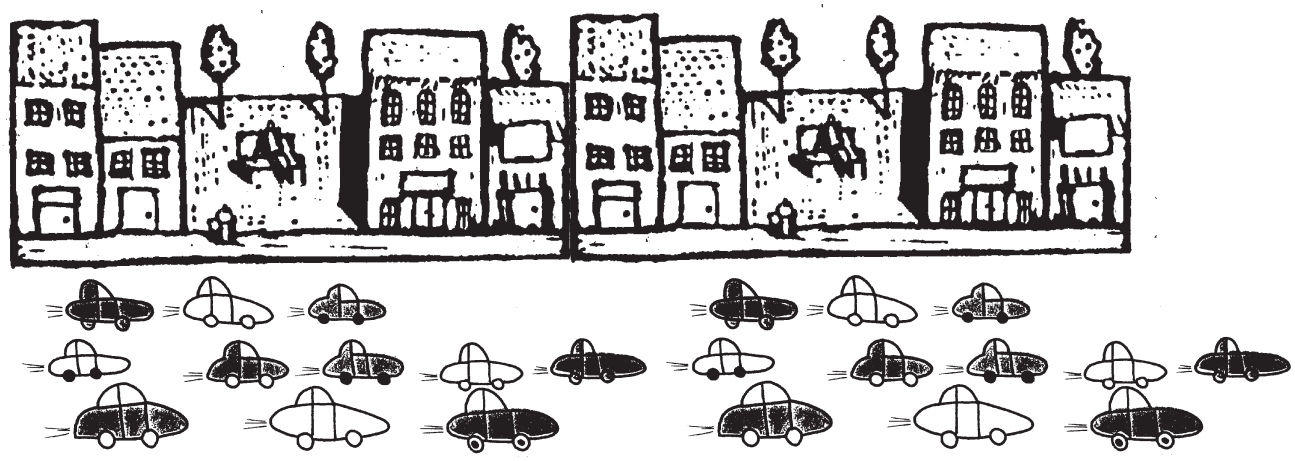
Instructions continued

Other Activities:

1. Research how the Kentucky Division for Air Quality's monitors work.
2. Research fossil fuels and how each type of fuel impacts air quality.
3. Visit a local industry or power plant to see their air pollution control devices or invite their representative to class to discuss air pollution issues and how the company minimizes its impact.
4. Determine the major source of energy used in your community. How does that source impact the air quality in your area? Make a list of ways you can decrease your use of that energy source.
5. Invite a meteorologist to your classroom to explain how weather influences our air quality and to inform you about careers in this field.

References/Additional Resources

Kentucky Division for Air Quality, 314 St. Clair St., Frankfort, KY 40601, 502-564-3382, oversees the regulation and monitoring of air pollution in Kentucky. The Division also has regional offices throughout the state. Contact the Division to locate your regional office or to report an air pollution complaint.



Activity 1. Understanding Air Pollution
Worksheet #1

How Air Quality is Monitored in Kentucky

There are more than 3,000 regulated air pollution sources in Kentucky. Nearly 300 are considered major industrial sources, releasing 100 tons or more of various pollutants into the air each year. Some pollutants you can see like smog or dust in the air. But other pollutants are invisible and more difficult to detect.

It would be impossible to physically measure every source of air pollution. Instead, the state determines the quality of our air through the use of air pollution monitors, mathematical calculations, and a variety of tests to measure the level of pollutants released from the stacks of various industrial plants.

The Kentucky Division for Air Quality (DAQ) operates a network of 53 monitoring stations across the state. These stations provide data used to determine whether air quality is meeting federal and state standards established to protect our health. If air quality does not meet the standards, the state issues violations to those companies not complying with the law and may impose penalties and fines.

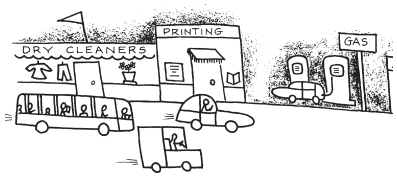
Air pollution monitors are located in all regions of the state. Your county is located within one of the nine Air Quality Control Regions that have been established in Kentucky. The regions are shown in Figure 1.

On the following pages the air quality data regarding various air pollutants has been averaged for each region of the state. However, it is possible that air pollution levels in your community might be higher or lower than the average shown for your region, although the average gives a general estimate of typical conditions in the area where you live.

Air Quality Control Regions

Source: Kentucky Division for Air Quality, 1991

Worksheet #1 continued



Group A: Issue Paper

Ozone Pollution Problems Difficult to Solve

Most of us are familiar with smog, the haze that forms over a city usually during the hot months of summer. Ozone, commonly called smog, is formed when automobile exhaust, vapors from gasoline, solvents, paints, and other pollutants chemically react in the presence of sunlight. Ground level ozone is a pollutant and should not be confused with the ozone in the upper atmosphere, which protects the Earth from ultraviolet radiation. High levels of ground level ozone can cause or aggravate respiratory problems such as asthma and can stress the heart.

The average concentration of smog varies throughout the state. High ozone concentrations are most prevalent in urban areas during the summer months when the air is hot and stagnant. But winds can also carry ozone, or the pollutants that form ozone, to surrounding areas.

In most cases less populated areas with few industries do not have ozone pollution problems. Nearly all problems occur in metropolitan areas, such as Louisville and Northern Kentucky, or in rural areas that have high industrial releases of certain chemicals associated with the formation of ozone, such as in Boyd and Marshall counties.

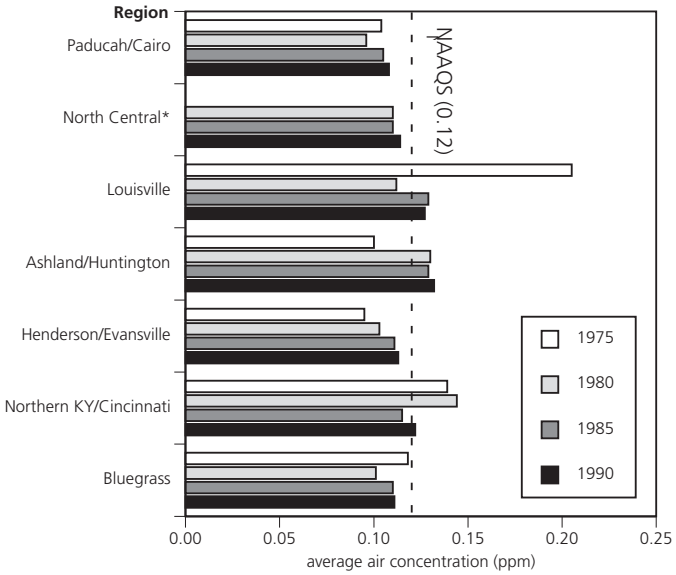
Several Counties Must Make Greater Efforts to Reduce Ozone

Ozone standards were exceeded most often in 1980, 1983, and 1988, both nationally and in Kentucky (Figure 2). Average ozone levels in Jefferson, Boone, Campbell, Kenton, and Boyd counties exceeded the standard in 1990. These five counties, as well as portions of Bullitt, Greenup, and Oldham counties, are classified as "moderate nonattainment" for ozone meaning that they must institute measures to achieve reductions in the pollutants associated with ozone formation.

Efforts to Control Ozone Include Vehicle Testing, Controlling Releases From Dry-Cleaners

Reducing certain air pollutants including carbon monoxide, oxides of nitrogen, and highly reactive chemicals known as Volatile Organic Compounds (VOCs), have helped address ozone pollution problems in many areas of the state. Regulations adopted in the 1970s focused on reducing these pollutants from industrial sources. In the late 1970s and early 1980s, releases of these pollutants linked to ozone formation from dry-cleaners and automobile exhaust began to be controlled.

Figure 2
Average Air Concentration of Ozone in Kentucky



Notes: The ozone standard was made less stringent in the late 1970s.
** 1975 data for the N. Central Region was unavailable. PPM is the abbreviation for "parts per million," a measurement of the concentration of a substance within the air.*

The dotted line in figure 1 represents the National Air Quality Standard (NAAQS), which are limits on the amount of a pollutant allowed in the air. When values fall below that line, it indicates that the standard is met. If higher, the average air concentration violates the standard set to protect health. The data shown for a region is the average of all the monitored sites in that area. Concentrations may be higher or lower than the regional average at any given monitoring site.

Source: Kentucky Division for Air Quality monitoring data, 1991

Worksheet #1 continued

Group A: Continued

Eight Counties Still Cannot Meet Ozone Standard

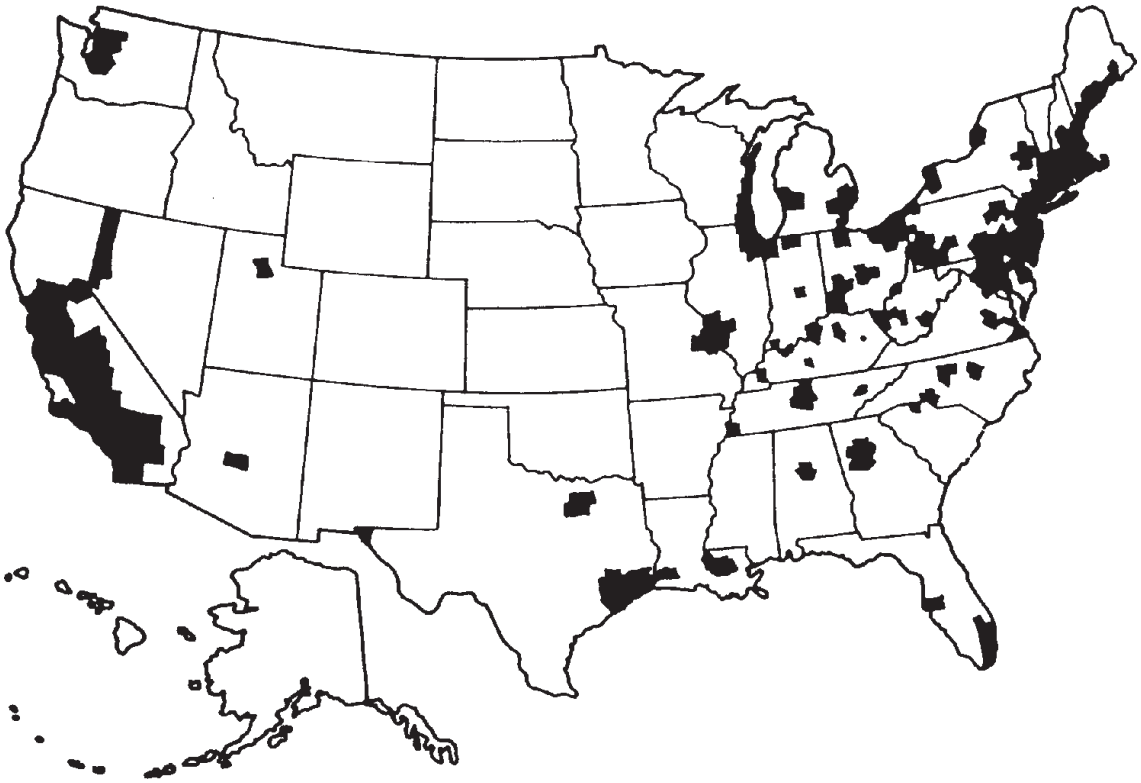
These pollution controls were still not enough to meet ozone standards in some areas of the state. The eight counties in Kentucky designated as "moderate nonattainment" for ozone may be required to install additional controls at gas pumps to recover vapors and either strengthen or begin testing vehicles to better control pollution created by burning gasoline.

The federal Clean Air Act Amendments passed by Congress in 1990 require Kentucky and other states to evaluate air pollution from industries, vehicles, dry cleaners, paint shops, and service stations, in areas failing to meet the ozone standard and develop a strategy to further reduce the pollutants associated with ozone by at least 15% by 1996.

The federal government is requiring some products, such as gasoline and chemical solvents, to be reformulated to reduce vapors released during their use. This will assist in controlling ozone pollution. However, meeting the 15% reduction in the state's ozone "moderate nonattainment" areas by 1996 will be particularly challenging because many of the relatively "easy" reductions have already been accomplished through earlier controls.

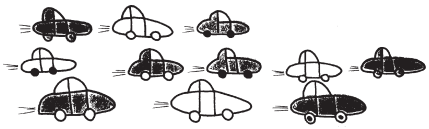
It is predicted that the increasing number of vehicles and miles traveled, an expanding population, and economic growth will offset much of the ozone pollution reductions achieved by control programs. We may see ozone levels increase in spite of the controls unless we make aggressive efforts to conserve energy and seek new ways to minimize pollution from the burning of fuels.

Areas in The United States with Ozone Pollution Problems



Note: Dark areas on the map are ozone nonattainment areas as of 4/93.
Source: U.S. Environmental Protection Agency, document EPA400-K-93-001.

Worksheet #1 continued



Group B: Issue Paper

Carbon Monoxide Released by Automobiles Contributes to Air Pollution Problems

Most of us have been behind a car that was emitting huge clouds of white smoke. That smoke indicates that carbon monoxide is being released by the vehicle. It not only smells bad, but can cause serious air pollution problems as well. Carbon monoxide (CO) is a poisonous gas formed when fossil fuels, such as gasoline and coal, fail to combust completely. Carbon monoxide may cause serious health problems, including dizziness and slowed reflexes, when standards are exceeded. Very high concentrations can lead to death.

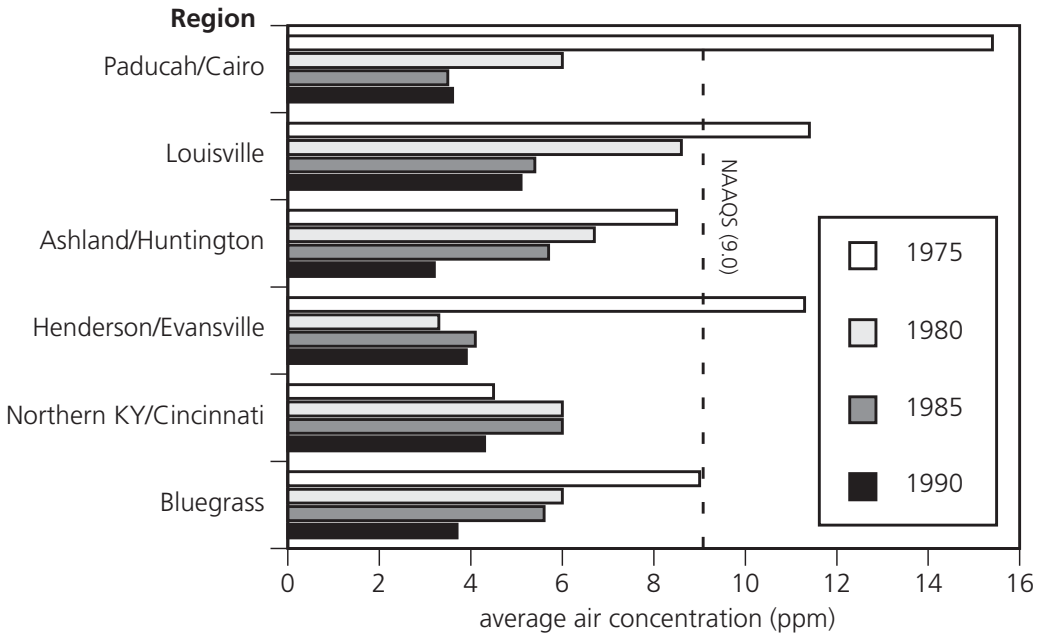
Emission Controls Help Reduce Carbon Monoxide Levels

State and federal regulations and standards to control releases of carbon monoxide have been effective in reducing air levels statewide (Figure 3). Because automobile exhaust is responsible for 97% of the carbon monoxide releases, the federal government required all vehicles built since 1974 to be equipped with catalytic converters to absorb this pollutant. This has resulted in national and statewide reductions in the amount of CO in the air. Five of the six Air Quality Control Regions in the state with carbon monoxide monitoring had significant, steady decreases in the amount of carbon monoxide measured in the air between 1975 and 1990.

Further reductions in CO releases are expected since controls used to reduce ozone and other air pollutants required under the federal Clean Air Act Amendments passed by Congress in 1990 will also limit carbon monoxide releases.

Figure 3

Regional Air Concentrations of Carbon Monoxide in Kentucky

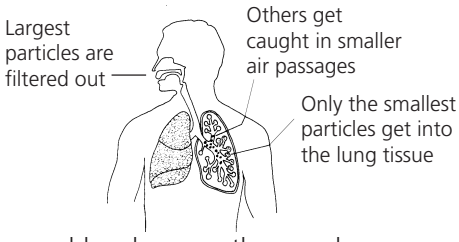


PPM is the abbreviation for "parts per million," a measurement of the concentration of a substance within the air.

The dotted line in Figure 3 represents the National Air Quality Standard (NAAQS), which are limits on the amount of a pollutant allowed in the air. When values fall below that line, it indicates that the standard is met. If higher, the average air concentration violates the standard set to protect health. The data shown for a region is the average of all the monitored sites in that area. Concentrations may be higher or lower than the regional average at any given monitoring site.

Source: Kentucky Division for Air Quality monitoring data, 1991

Worksheet #1 continued



Group B - Continued

Particles in the Air Can Impact Health

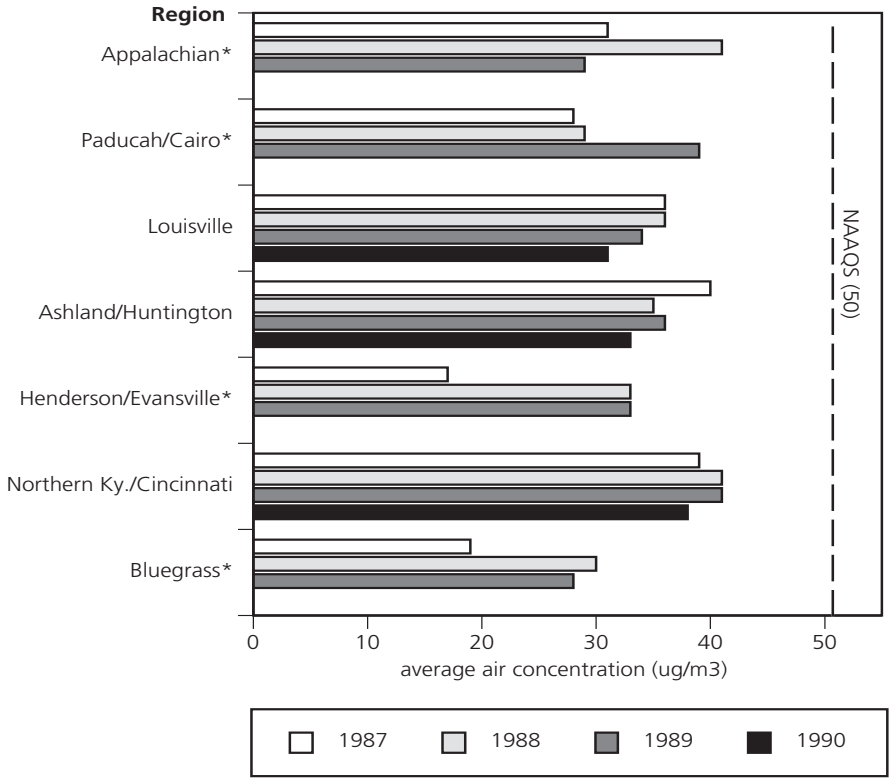
Small particles in the air, like dust and soot, are considered an air pollution problem because they can become lodged in our lungs and affect our health. The air quality standard for airborne particles is presently being met in all of the state's monitored Air Quality Control Regions as can be seen in Figure 4. The current standard, known as PM_{10}, requires small particles (those less than 10 microns in diameter), which are directly associated with health problems, to be monitored and controlled.

Small airborne particles come from many sources. These pollutants are released by industrial plants, construction activities, mining, stone crushing, and during the burning of fuels in industrial boilers and furnaces. Other sources of particles include soil from farmland plowing, unpaved roads, and open burning. During 1990, the Kentucky Division for Air Quality received 346 complaints regarding open burning, many of which involved black smoke from burning tires.

Reducing releases of toxic air pollutants from industrial plants, which can adhere to dust and other small particles, may also assist in reducing health risks from airborne particles. The federal government recently announced that it will be re-examining the impacts of particulates in light of new scientific evidence indicating airborne particles may be an even greater health risk than previously believed.

Figure 4

Regional Concentrations of Airborne Particles (PM_{10}) in Kentucky



**Monitoring not conducted in 1990.*

ug/m3 is the abbreviation for "micrograms per cubic meter, a measurement of the concentration of a substance in the air.

The dotted line in Figure 4 represents the National Air Quality Standard (NAAQS), which are limits on the amount of a pollutant allowed in the air. When values fall below that line, it indicates that the standard is met. If higher, the average air concentration violates the standard set to protect health. The data shown for a region is the average of all the monitored sites in that area. Concentrations may be higher or lower than the regional average at any given monitoring site.

Source: Kentucky Division for Air Quality monitoring data, 1991

Worksheet #1 continued

Group B - Continued

Lead in the Air Declining Significantly

High levels of lead in the air are very harmful to humans, causing many health problems including brain damage. Lead is also harmful to our streams, fish and other aquatic organisms that depend on clean water. The greatest source of lead in the past has been gasoline used in automobiles and other vehicles.

Phase-Out of Leaded Gas Primary Reason Why Lead in the Air Has Declined

The decreasing trend in lead levels in the air shown in Figure 5 is due largely to the national phase-out of leaded gasoline during the 1970s and 1980s. Unleaded gasoline was introduced in 1975. However, the increasing level of lead in the air led the federal government to take action and begin to phase-out lead in gasoline. By 1989, 89% of all gasoline sold nationwide was unleaded. And the results have been dramatic. Between 1980 and 1989, lead levels in the air decreased nationally by 90%. In 1985, 73% of all lead releases into the air came from vehicles; by 1989, this total had declined by 31%.

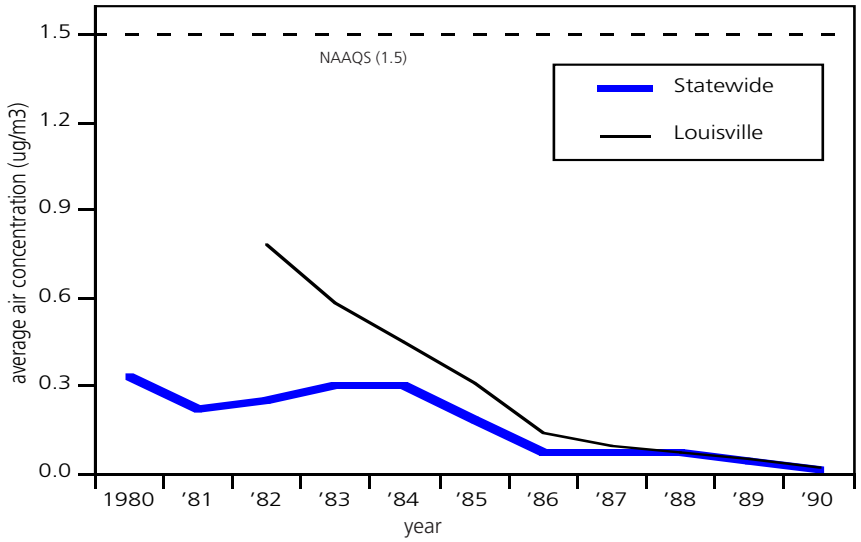
The Louisville Air Quality Control Region has historically had the highest average lead air concentrations in the state. By 1990, lead levels in Louisville had declined 99%. However, lead levels in the soil have been shown to exceed safe levels in many areas of the city. Soil contamination occurred primarily as a result of the transfer of lead from the air through rainfall and by other means into the soil.

Declines in air lead levels were also recorded during this same period for other Air Quality Control Regions of the state. Monitoring for lead is no longer being conducted statewide in Kentucky. However, monitoring is ongoing in Greenup County near the Armco Steel plant and at two sites in Jefferson County where industries release lead into the air. None of these areas currently violate the lead standard. Releases of lead into the air from some manufacturing industries have been reported to the state since 1987. In 1990, these industries reported releasing 36,662 pounds of lead and lead compounds into the air compared to 43,688 pounds in 1989.

The overall decline of lead in our air represents important progress in cleaning our air and making it healthy for people to breathe.

Figure 5

Statewide* Average Air Concentration of Lead in Kentucky

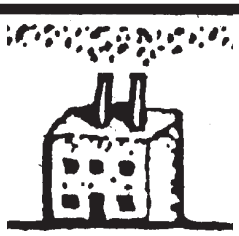


*Note: *After 1980 most state lead monitoring was limited to a few industrial sites. Statewide averages were based on all available data.*

ug/m3 is the abbreviation for "micrograms per cubic meter, a measurement of the concentration of a substance in the air. The dotted line in Figure 5 represents the National Air Quality Standard (NAAQS), which are limits on the amount of a pollutant allowed in the air. When values fall below that line, it indicates that the standard is met. If higher, the average air concentration violates the standard set to protect health. The data shown for a region is the average of all the monitored sites in that area. Concentrations may be higher or lower than the regional average at any given monitoring site.

Source: Kentucky Division for Air Quality monitoring data, 1992.

Worksheet #1 continued



Group C: Issue Paper

Sulfur Dioxide Gas Linked to the Formation of Acid Rain

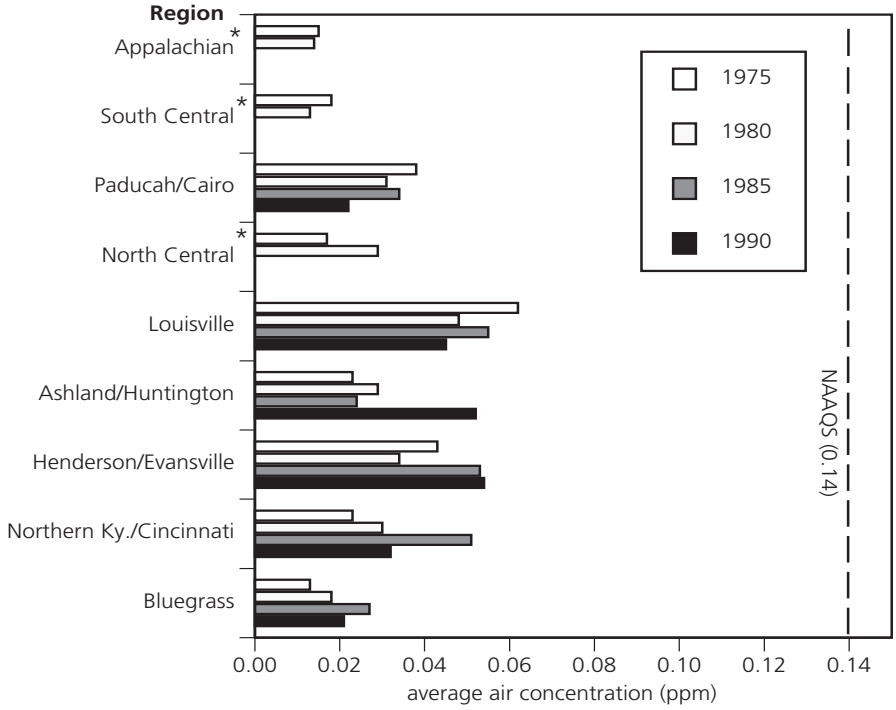
Sulfur dioxide (SO_2) is a pungent, colorless gas that affects our lungs, irritates our eyes, injures fish and other types of aquatic life, and is linked to the formation of acid rain. The major source of SO_2 in Kentucky is power plants that burn coal to generate electricity. These sources alone account for 85% to 90% of all statewide SO_2 releases into the air.

All Air Quality Control Regions in Kentucky meet the air quality standard for SO_2, with the exception of a portion of Boyd County near Catlettsburg. Although the SO_2 air quality standard is generally being achieved throughout the state, several regions appear to have had higher average daily concentrations of sulfur dioxide in 1990, compared to levels recorded in 1975 (Figure 6). The Kentucky Division for Air Quality indicates that this was not unexpected since additional regulatory requirements were not imposed to reduce SO_2 releases.

However, the federal Clean Air Act Amendments passed by Congress in 1990 require major reductions in SO_2 releases between now and the year 2000, due to increasing evidence of the environmental, health, and economic impacts of acid rain. The formation of acid rain is linked to SO_2 released when burning coal for energy. These pollutants are then transported far downwind where they chemically react to form acid rain. Acid rain is thought to be polluting lakes in Canada and in the Northeastern United States, as well as areas of Europe.

Figure 6

Regional Air Concentrations of Sulfur Dioxide in Kentucky



** Three regions had no SO_2 monitoring in 1985 and 1990.*
PPM is the abbreviation for "parts per million," a measurement of the concentration of a substance in the air.

The dotted line in figure 6 represents the National Air Quality Standard (NAAQS), which are limits on the amount of a pollutant allowed in the air. When values fall below that line, it indicates that the standard is met. If higher, the average air concentration violates the standard set to protect health. The data shown for a region is the average of all the monitored sites in that area. Concentrations may be higher or lower than the regional average at any given monitoring site.

Source: Kentucky Division for Air Quality monitoring data, 1991

Worksheet #1 continued

Group C-Continued

New Controls Will Require Coal Burning Power Plants to Reduce Sulfur Dioxide

In an attempt to improve our air quality and reduce the pollutants linked to the formation of acid rain, the U.S. Congress set limits on the amount of SO_2 that can be released nationwide as part of the Clean Air Act Amendments of 1990. A cap was set to limit the total SO_2 released into the air to 8.9 million tons annually. The cap will require coal burning power plants to become more efficient as the demand for electricity grows and will encourage additional pollution controls or closure of older inefficient power plants. It will also encourage increased use of coal with lower sulfur content and promote use of new technologies to control SO_2 pollution.

One technology used by coal burning power plants to reduce SO_2 releases is to install "scrubbers." Scrubbers are air pollution control devices that trap some pollutants before they are released to the air. Scrubbers have helped to reduce Kentucky's SO_2 releases from 1.3 million tons in 1976 to 675,000 tons in 1990, a 48% decline. Most of these reductions occurred during the early and mid–1980s.

Nitrogen Oxides Produced When Fossil Fuels Burned

Nitrogen oxides (NO_x) are produced when petroleum and coal are burned by power plants, industries, in motor vehicles, and other sources. Air quality standards limiting the amount of nitrogen dioxide (NO_2) allowed in the air were established because high concentrations are known to affect human health. Nitrogen oxides also combine with water to form an acid and contribute to the formation of acid rain and ozone (smog) pollution.

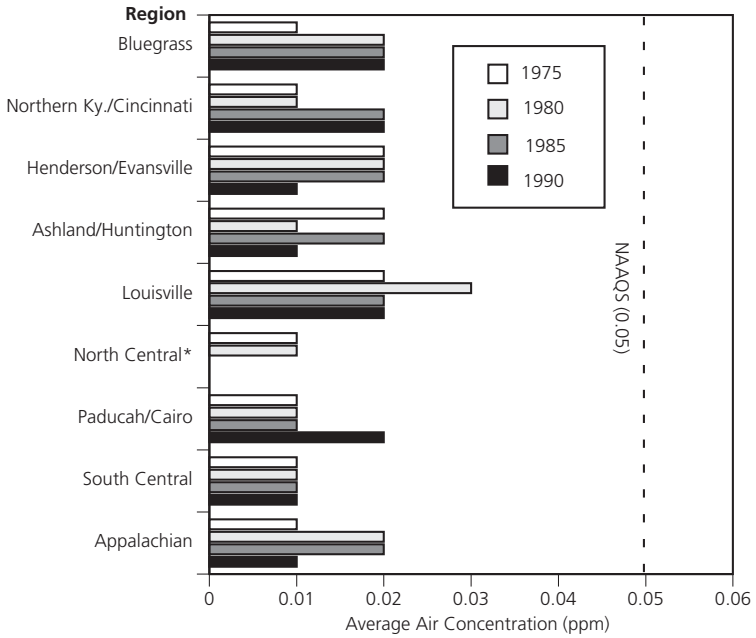
Technological controls to reduce NO_2 releases from industrial sources have assisted in reducing this pollutant. Nitrogen oxides released from automobiles and industrial chemical processes are being better controlled by the use of air pollution control devices such as catalytic converters.

All monitored Air Quality Control Regions of Kentucky currently meet the air quality standards for NO_2 (Figure 7). Regional data show, however, that average air concentrations of NO_2 were increasing during 1990 in three of the state's nine regions.

Strategies are being developed to further reduce NO_x releases from vehicles and industrial sources in communities that have smog problems. The federal government is required to establish stricter NO_x requirements for power plants and industrial boilers by 1994.

Figure 7

Regional Air Concentration of Nitrogen Dioxide in Kentucky



Note: Values were rounded to the nearest one–hundredth.
** N. Central Region not monitored in 1985-1990*
PPM is the abbreviation for "parts per million," a measurement of the concentration of a substance within the air.
The dotted line in Figure 7 represents the National Air Quality Standard (NAAQS), which are limits on the amount of a pollutant allowed in the air. When values fall below that line, it indicates that the standard is met. If higher, the average air concentration violates the standard set to protect health. The data shown for a region is the average of all the monitored sites in that area. Concentrations may be higher or lower than the regional average at any given monitoring site.
Source: Kentucky Division for Air Quality monitoring data, 1991

Activity 2. Measuring Your Air Quality

Instruction Sheet

DO YOU KNOW. . .

- What factors influence the quality of your air?
- How to get information about air quality in Kentucky?
- What to do if you suspect there is an air pollution problem?

Daily Air Reports Provide Citizens With Access to Air Quality Conditions

The good news is Kentucky's air quality has generally improved during the last 20 years, primarily because of the control of pollutants such as ground level ozone, small airborne particles also known as particulates, and nitrogen dioxide. But maintaining these improvements by regulating 3,000 industrial sources of air pollution in Kentucky is a significant challenge. Other sources of air pollution including automobiles, dust, and open burning, are also contributing to air quality problems.

Air pollution can have a significant impact on our health. The elderly and people with asthma and other respiratory problems are particularly sensitive to high levels of air pollution, as are children. In response, the federal government has developed an Air Quality Index (AQI) to give the public a daily air pollution report and provide warnings when the air becomes unhealthy. AQI readings are also used to analyze trends and to compare air quality in different areas across Kentucky.

Purpose:

In this activity you will monitor air quality in Kentucky by tracking the "Air Quality Index" and other information on datasheets. You will track problem pollutants and discuss how our daily activities may be contributing to air pollution problems.

Procedure:

(Note to teacher: This activity is best done after Activity #1, "Understanding Air Pollution" has been completed.)

Part I - Monitoring Air Quality in Kentucky

1. Obtain Worksheet #1 from your teacher. As a class, discuss how the weather and other factors influence our air quality. Review the Air Quality Index and the data sheet. (Note to teacher: Each student will need seven copies of Air Quality Index Data Sheet.)
2. Divide into teams. Each team will be assigned a week to record the Air Quality Index for the seven areas monitored in the state. Each team will monitor the Air Quality Index during their assigned period by calling the toll-free number on Worksheet #1. Each team will monitor the Air Quality Index during their assigned period by calling the toll-free number on Worksheet #1.

(Note to teacher - It may be interesting to have each team check the AQI for one week of each month of the school year to see how the weather and seasonal activities influence air quality. Shorter timeframes, however, will also work.)

3. Track the Air Quality Index for your designated time period on the data sheet. List the date, the value, the pollutant of concern, weather conditions, and any health advisories. You will need a data sheet for each of the seven areas listed on Worksheet #1.
4. Create a class display to track the data collected.

Part II - Putting Your Knowledge to Work

1. Once the data collection for all teams is complete, each team should compare and summarize the results, and answer the following questions:
   A. Which areas of the state had highest pollutant value reading? List in order (from high to low).
   B. Which air pollutant was the biggest problem? What factors do you think made the reading high?

Instructions continued

C. Who should be concerned if the Air Pollution Index is high? Why ?
D. What do you think would happen if the area with the highest air pollution index reading doubled it's population? If the population were reduced by half? Explain your answers.
E. How do your actions influence air quality? Are there ways you can minimize your impact? Explain.

2. Report your group's findings to the class. As a class, discuss the results.

Other Activities:

1. Research how the Air Quality Index is calculated and interpreted.
2. Design an air quality "monitoring program" for your school by using the Air Quality Index, if available for your area, and/or observations regarding haze, odors, etc. Maintain the information in a public area of your school.

Activity 2. Measuring Your Air Quality

Worksheet #1

Air Quality Index Offers Public Information

Want to know how clean your air is today? The answer is just a phone call away. The federal government has developed an Air Quality Index (AQI) in Kentucky to give the public a daily air pollution report and provide warnings when the air becomes unhealthy.

AQI readings are also used to analyze trends and to compare air quality in urban areas across the United States. The AQI provides a simple, uniform way to report daily air pollution concentrations, to tell the public about the general health effects associated with these concentrations, and to describe general precautionary steps that can be taken to protect public health.

AQI is a reporting tool that converts the pollutant concentrations measured in a community's air to a simple number on a scale of 0-500. Intervals on the AQI scale are related to the potential health effects of five major air pollutants: carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and particulate matter. The report gives the pollutant index number and the problem pollutant. It also tells you whether the air is categorized as "good, moderate, or unhealthy" to breathe.

CALL 1-800-AIR IN KY

Information regarding air quality in Kentucky is updated everyday for seven areas: Ashland, Henderson, Lexington, Louisville, Northern Kentucky, Owensboro, and Paducah. Simply call the toll-free number, 1-800-247-4659.

Index Value	AQI Descriptor	General Health Effects	Cautionary Statements
500	Hazardous	Premature death of ill and elderly people. Healthy people will experience adverse symptoms that effect their normal activity.	All persons should remain indoors, keeping windows and doors closed. All persons should minimize physical exertion and avoid traffic.
400-300		Premature onset of certain diseases in addition to significant aggravation of symptoms and decreased exercise tolerance in healthy people.	Elderly and persons with existing diseases should stay indoors and avoid physical exertion. General population should avoid outdoor activity.
200	Very Unhealthy	Significant aggravation of symptoms and decreased exercise tolerance in persons with heart or lung disease with widespread symptoms in the healthy population.	Elderly and persons with existing heart and lung problems should stay indoors and reduce physical exertion.
100	Unhealthy	Mild aggravation of symptoms in susceptible persons, with irritation symptoms in the healthy population.	Persons with existing heart or respiratory ailments should reduce physical exertion and outdoor activity.
50	Moderate	Breathe with caution	
0	Good	Breathe deeply and enjoy!	

Measuring Air Quality

To Breathe or Not To Breathe...That is the Question

Air Quality Index DataSheet

Area _____

Date	AQI Value	Pollutant	Weather Condition	Health Advisory

What You Can Do:

Report all air pollution incidents such as tire burning or heavy smokestack releases to the Kentucky Division for Air Quality at 502-564-3382 or the Kentucky Environmental Response Team at 1-800-928-2380.

Activity 3 Acid Rain in Kentucky

Instruction Sheet

DO YOU KNOW. . .

- Why Kentucky's rainfall is more acidic than normal rain and has become more acidic during the last several years?
- Why acid rain has not yet noticeably damaged our state's waterways, as has been the case in the Northeastern United States and Canada?

Kentucky's Rain Getting More Acidic

Deep in Lilley Cornett Woods, among the last remaining acres of unlogged forest left in Kentucky, scientists are monitoring the pH or acidity of our rainfall. The monitoring has been ongoing for several years due to concern that changes in rainfall pH may be impacting the health of our forests and waterways.

The problems associated with "acid rain" have been well documented in the U.S. and other countries. The water quality of thousands of lakes and streams has been impacted by acid rain. In some areas, waterways have become so acidified that they no longer support fish and other types of aquatic life. Acid rain also damages buildings and statues and is harmful to humans.

The Kentucky scientists' tests have shown that rainfall in the state has become more acidic since their monitoring began in the forest and other areas in 1985. Kentucky rainfall is now more acidic than normal rain. The suspected source of the acid rain problem is releases of sulfur dioxide and nitrogen oxides into the air when fossil fuels, such as coal and petroleum, are burned for energy.

Rainwater is naturally acidic due to the chemical reaction between the rain and carbon dioxide gas in the atmosphere. The reaction results in the formation of carbonic acid ($H_20 + CO_2 = H_2CO_3$). The amount of carbon dioxide in the atmosphere has risen due to the burning of fossil fuels. Additionally, releases of sulfur dioxide and nitrogen oxide into the air lead to the formation of sulfuric and nitric acid in rainfall.

It is important to increase our understanding of how the formation of acid rain occurs and what can be done to limit releases of these chemicals so we can work effectively to reduce the ecological and human health problems it causes.

Purpose:

In this activity you will analyze the impact of acid rain and determine if it is a problem in Kentucky. You will also assess conditions in your community by tracking the acidity of rainfall where you live and comparing it to statewide trends.

Procedure:

Part I - Learning More About Acid Rain

1. Obtain Worksheet #1 from your teacher. Review, discuss, and answer questions.

Part II - Assessing the Problem of Acid Rain In Kentucky and Your Community

(Note to teacher: You will need to provide students pH strips or have a pH meter available and instruct students on the proper use of these items.)

1. Each student will select an area to test the pH of rainwater. This may be at school, home, or a local business. Record the pH for a designated period of time as specified by your teacher.
2. Create a chart to display your findings. Compare your findings with the rest of the class. Discuss why the pH you recorded may be different from the state average rainfall pH in Figure 2 of Worksheet #1.
3. Prepare a class display that shows the results of your monitoring including the sampling locations and other appropriate information.

Instructions continued

Other Activities:

1. Research the impact of acid rain in European countries. Compare their problems and efforts to address acid rain to those in the United States.
2. Conduct the following experiment to investigate the basis of the chemical reactions that occur when acid rain is formed:

   A. Place a small chunk of dry ice in a flask of water. Do not touch the dry ice with your bare skin. Use gloves and tongs. You will observe the physical sublimation of the frozen CO_2 to a gaseous form.

   B. Repeat the above procedure but use a weak basic solution of sodium hydroxide or a concentrated solution of baking soda. Add a few drops of universal pH indicator which will turn purple with the weak basic solution. This time the solution will turn colors ranging from purple, to blue, to green, to yellow, and ending with orange. The color change visually illustrates the acid formation when CO_2 dissolves in the water.

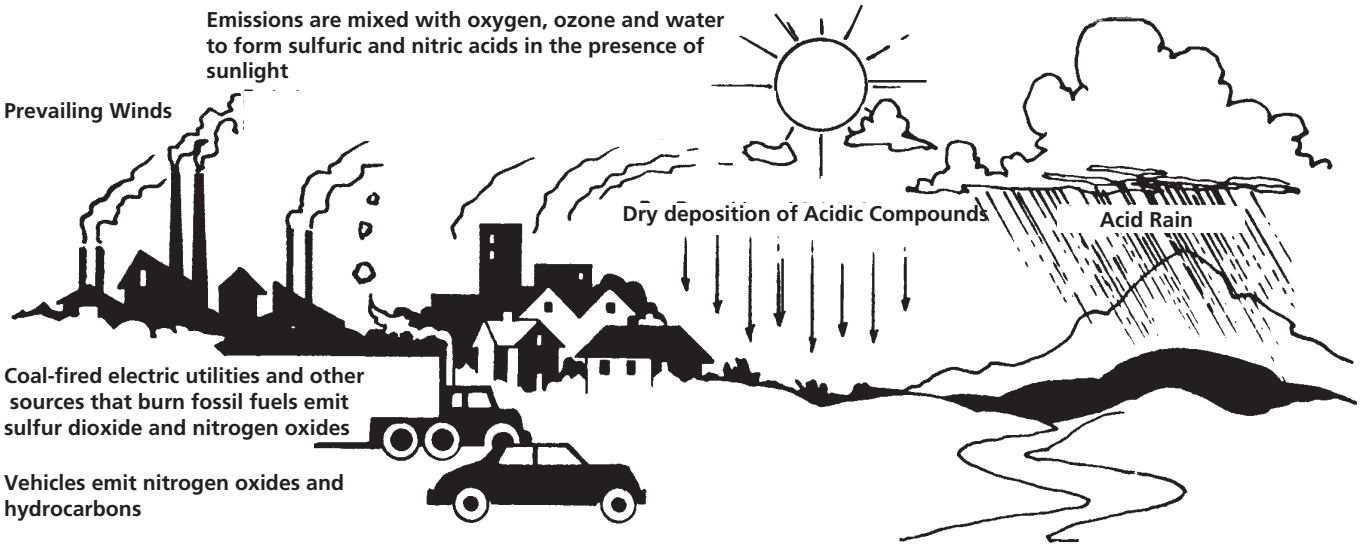
   C. Compare the chemical reactions to acid rain formation and its potential impact on aquatic and terrestrial ecosystems.

3. Take a field trip to a power plant or invite a representative of the electric company to school to learn more about how the pollutants linked to acid rain are controlled.

References/Additional Resources:

1. Acid Rain Information Clearinghouse, 46 Prince Street, Rochester, NY 14607, telephone: 716-262-2870, is a project of the Center for Environmental Information, Inc., a nonprofit organization. ARIC is a national resource center for both technical and general information on acid rain.

How Acid Rain Occurs



Activity 3. Acid Rain In Kentucky
Worksheet #1

"Acid Rain" is Local and Global Problem

Some air pollution problems result from the transport of pollutants hundreds of miles downwind of the area from which they were released. One of these problems is acidic deposition, commonly known as "acid rain." Many scientists attribute the formation of acid rain to releases of sulfur dioxide (SO_2) and oxides of nitrogen (NO_x) when fossil fuels such as coal and petroleum are burned for energy.

In the United States, 4.2% of all lakes and 2.7% of all streams monitored are acidified, according to a 1991 study reported by the National Acid Precipitation Assessment Program. This report indicates that one-third of the acidification occurred in the Northeastern U.S., one-third in Florida, and one-third in the Midwest. Canadian studies have concluded that an estimated 45,000 lakes are so acidic that they no longer support normal fish and other aquatic populations.

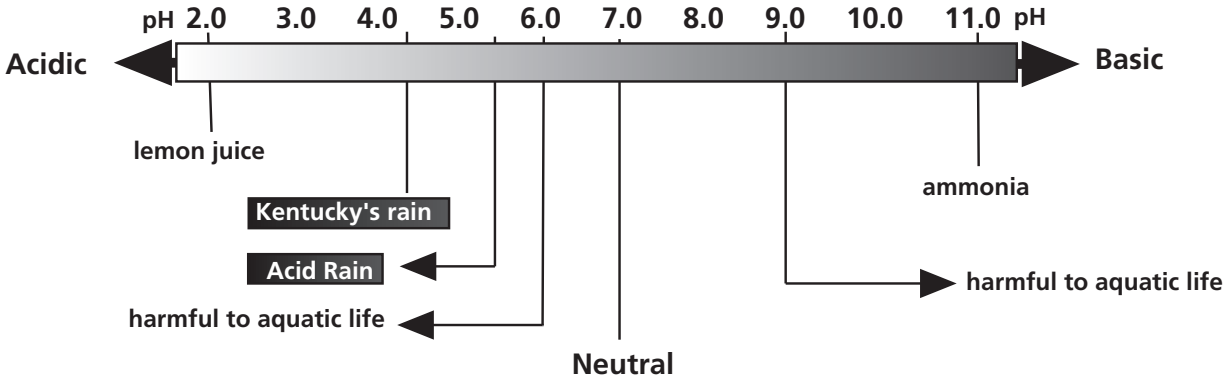
In addition to lake and stream acidification, acid rain is blamed for premature deterioration of buildings and statues, adverse health effects, and damage to forests and other vegetation. Much of the damage is believed to be caused by SO_2 and NO_x released by coal-fired power plants located in the Ohio River Valley Region which includes Kentucky. It is believed these pollutants are transported by winds to the Northeastern U.S. and Canada where they help to form acid rain that damages lakes and other waterbodies.

Burning of Coal for Electricity Linked to Acid Rain Problems

Power plants that burn coal to generate electricity contribute 85–90% of all SO_2 released in Kentucky, therefore, most efforts to reduce acid rain have been made at these facilities. Sulfur dioxide releases from power plants declined 48% between 1976 and 1990, from 1.3 million tons to 675,000 tons.

The reduction was due to the installation of "scrubbers" at some of the coal burning power plants in Kentucky. Scrubbers are air pollution control devices that remove some SO_2 before it is released to the air. About 43% of the coal burned in Kentucky's power plants in 1989 was "scrubbed." The remaining 57% that was not scrubbed accounted for 80% of the SO_2 released by power plants.

Figure 1 **pH Scale Used to Determine Rainfall Acidity**



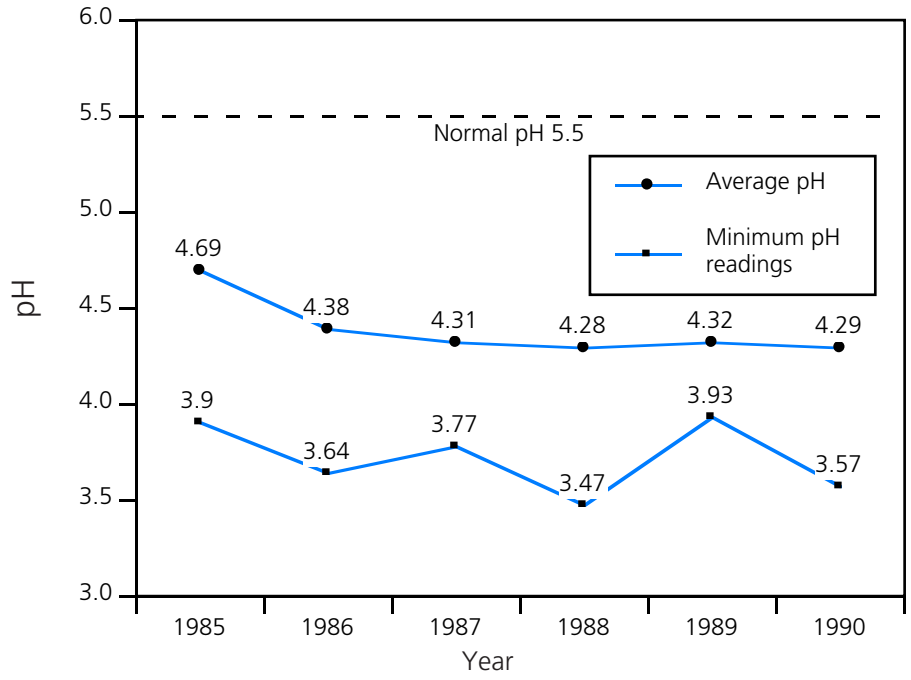
Note: Kentucky Water Quality Standards require the pH of our waterbodies to fall above 6.0 or below 9.0 to protect aquatic life.

Worksheet #1 continued

Although efforts made to reduce SO_2 releases into the air are noteworthy, our rainfall was more acidic in 1990 compared to 1985, as shown in Figure 2. The state's naturally alkaline rocks and soils appear to neutralize the acidity thus protecting the state's waters from any noticeable acidification damage so far.

Increasing evidence of the threats to the environment from acid rain have sparked more stringent measures to control this pollution. The federal Clean Air Act Amendments passed by Congress in 1990 require major reductions in SO_2 releases from coal burning power plants within the next five years, and additional reductions by the year 2000.

Figure 2
Average pH of Kentucky Rainfall



Note: Values shown are based on data collected at two monitoring stations in Kentucky and reflect the geometric mean rather than volume weighted averages.
Source: Kentucky Division for Air Quality monitoring data, 1991

Questions?

1. What is acid rain and what causes it?
2. Does Kentucky have an acid rain problem? Explain your answer.
3. If the rate of change remains constant in Figure 2, what would you expect the average state rainfall pH to be for the year 2000?
4. Describe the efforts being made to control acid rain.
5. Describe how you contribute to the acid rain problem and what you can do personally to help reduce acid rain.

What You Can Do...

1. Form a school committee to research acid rain issues. Start a public awareness campaign to educate others about how they can help reduce the pollutants that are causing acid rain.
2. Reduce your use of fossil fuels to the lowest possible level by consuming less, conserving energy, and using fuel efficient cars and appliances.

Activity 4. Global Warming and Ozone Depletion: Defining Your Role in the Problem

Instruction Sheet

DO YOU KNOW. . .

- What global warming is and why it is believed to be occurring?
- What you can do to reduce the pollutants that are thought to be linked to the "greenhouse effect?"
- What is being done to protect the Earth's ozone layer?

Climate Change Strategies Addressed During Students' Environmental Summit

More than 300 students from 51 Kentucky schools converged upon Louisville in May 1993 to hold an "Earth Summit" to focus attention on environmental problems. The youth meeting was held as a follow-up to the 1992 international "Earth Summit" held in Rio de Janerio, Brazil. Leaders from nearly every nation in the world gathered in Rio to begin an international effort to address worldwide environmental problems such as global warming, ozone depletion, and acid rain.

At the Kentucky Youth Summit, teenagers and college students attended workshops that were organized, researched, and conducted by their peers. They focused on what needs to be done to solve environmental problems, especially global climate change, and how students can begin to take a larger role in problem solving, providing leadership, and educating others. The results of the student workshops were presented to high-ranking officials and other leaders from around the nation. These students and others across the country are taking environmental issues such as global warming seriously. They are not waiting for adults to solve the problems.

Purpose:

In this activity you will analyze your contribution to global warming and determine what you can do to help offset the pollutants associated with this complex problem. You will also investigate statewide trends in the release of chemicals that are depleting the Earth's protective ozone layer and believed to be contributing to global warming.

Procedure:

Part I - Investigating Global Warming and the Depletion of the Earth's Ozone Layer

1. Obtain Worksheet #1 from your teacher. Review and discuss in class the general issues associated with global warming.
2. Calculate your "contribution" to global warming by following the instructions on Worksheet #1.
3. Answer the questions on Worksheet #1.

Part II - The Global Warming Debate

1. Many argue that global warming is not a problem. Divide into 6 teams. Three teams will choose one side of this issue (global warming is an environmental threat). The other three teams will choose the other side of the issue (global warming is not an environmental threat). Research the latest information, debate in class whether global warming is or is not a problem, and suggest what needs to be done about it.

Part III - Taking a Position

1. Based on the debates and what you have learned about global warming, write a two-page position paper on whether or not you think global warming is an environmental threat to the world.
2. Summarize your position paper in a letter to your U.S. Congressional representative and ask for a response.
3. Discuss your responses in class and review how public knowledge and involvement plays a part in promoting change in our society.

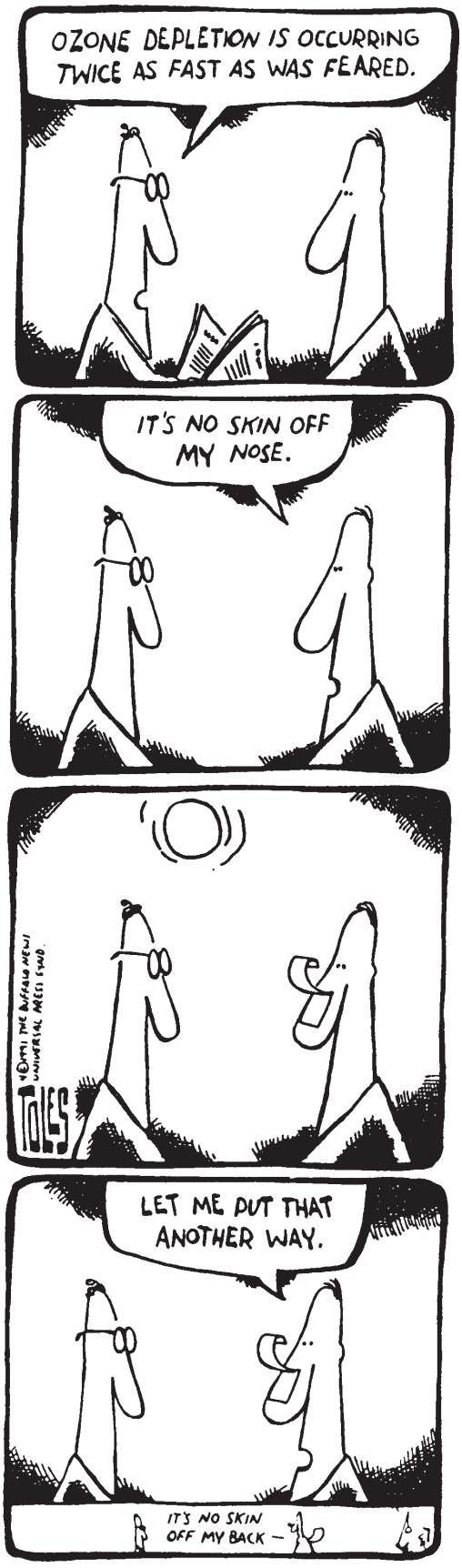
Instructions continued

Other Activities:

1. Investigate the United Nation's Global Climate Change Treaty and prepare a report on its provisions including the United States' role.
2. Research how the depletion of the rain forest is contributing to global warming.
3. Sponsor a class contest to see who drives the most fuel efficient car.

References/Additional Resources

1. Find out more about the Global Climate Change Treaty by contacting the United Nations, Department of Public Information, 484 Fifth St., NY, NY 10017, 212-963-7704.
2. NASA, the National Aeronautics and Space Administration has more information, free posters, and other materials related to global warming, ozone depletion and other atmospheric issues. Write to: NASA Publications, Code FEO-2 NASA Headquarters, Washington D.C. 20546, 202-453-1287, to request materials.
3. The worksheet calculations used to determine carbon dioxide emissions were adapted from "Global Warming and Personal Energy Use," by David Brook, Oregon State University, Extension Energy Agent, Feb. 1990.



Activity 4. Global Warming and Ozone Depletion: Defining Your Role in the Problem

Worksheet #1

Global Warming Most Complex Air Quality Problem Facing World Today

Holes in the atmosphere! Polar icebergs melting! Temperatures rising! Sounds like the makings of a television disaster movie. But many scientists are concerned that this may be a reality in the future. Global warming is believed to be one of the most complex air quality problems facing the world today. The apparent appearance of a slow, yet steady rise in the earth's average temperature is now attributed to increasing levels of greenhouse gases (carbon dioxide, nitrogen oxides, methane gas) in the atmosphere and the depletion of the Earth's protective stratospheric ozone layer.

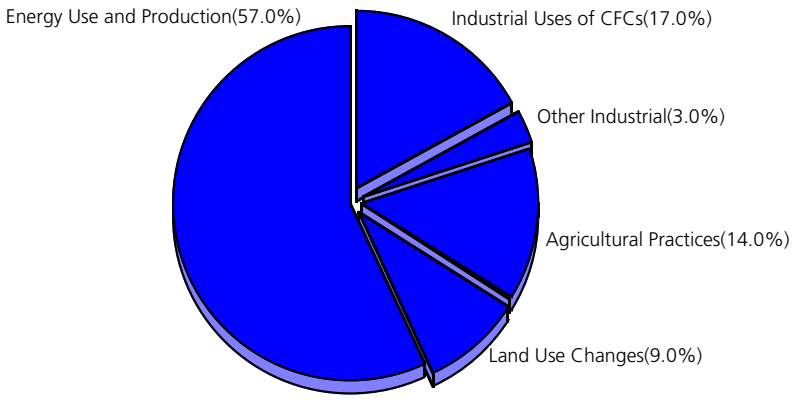
Naturally occurring gases in the atmosphere absorb the heat reflected from the Earth. This process, called the "greenhouse effect," warms the Earth making it habitable. However, many human activities, especially the burning of fossil fuels such as petroleum and coal, are suspected of contributing to global warming (Figure 1). Deforestation is also attributed to this problem since trees help to filter the pollutants linked to global warming.

The increase in greenhouse gases, coupled with the depletion of the Earth's protective ozone layer, is believed to be enhancing the greenhouse effect, causing average global temperatures to rise. Many scientists believe that the rising temperatures will have widespread impacts on climate, ocean levels, food production, and water supplies during the next several decades and beyond if we do not act swiftly to reduce greenhouse gases and ozone-depleting chemicals.

Scientific Studies Indicate Greenhouse Gases Increasing in the Atmosphere

Scientific studies indicate that greenhouse gases in the atmosphere have increased, contributing to rising global temperatures. Concentrations of carbon dioxide, the major greenhouse gas, have increased steadily since the 1980s. There has been a dramatic 25% increase in atmospheric carbon dioxide during the last 100 years, with the greatest rate of increase occurring since 1960, according to scientific reports.

Figure 1
Sources Contributing to Global Warming



Source: U.S. EPA and IPCC Scientific Assessment, 1991

Worksheet #1 continued

Carbon dioxide and nitrogen oxides come from many sources, but most are released when fossil fuels, such as coal and petroleum are burned for energy. Methane gas is produced by decaying vegetation, garbage, farm animals, and other sources. The clearing and burning of tropical rainforests and other land use changes contribute to global warming as well by reducing the Earth's ability to absorb greenhouse gases.

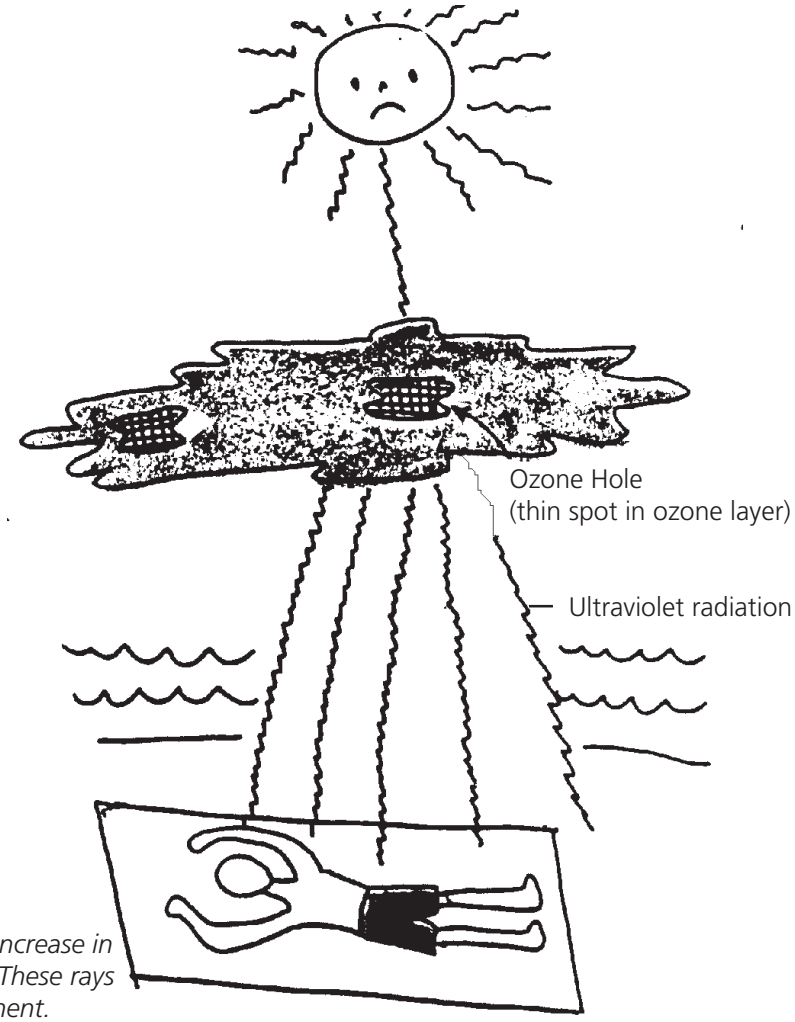
Ozone Depletion Contributing to Global Warming

The loss of the protective ozone layer is also believed to be contributing to global warming by allowing more of the sun's rays to pass through the earth's atmosphere and warm the planet. The ozone layer, which surrounds the earth and shields out ultraviolet radiation, is being destroyed at least twice as fast as was recently thought. An 11-year study by the National Aeronautics and Space Administration indicates that 4.5% of the ozone layer over the United States has been lost since measurements began in 1978.

Stratospheric ozone depletion can cause other problems as well, including damage to plants and humans by allowing more harmful ultraviolet radiation to penetrate through the Earth's atmosphere. The loss of the stratospheric ozone layer is causing a dramatic increase in the number of skin cancers and related deaths worldwide and in the U.S.

Loss of Ozone Layer Linked to Use of Certain Chemicals

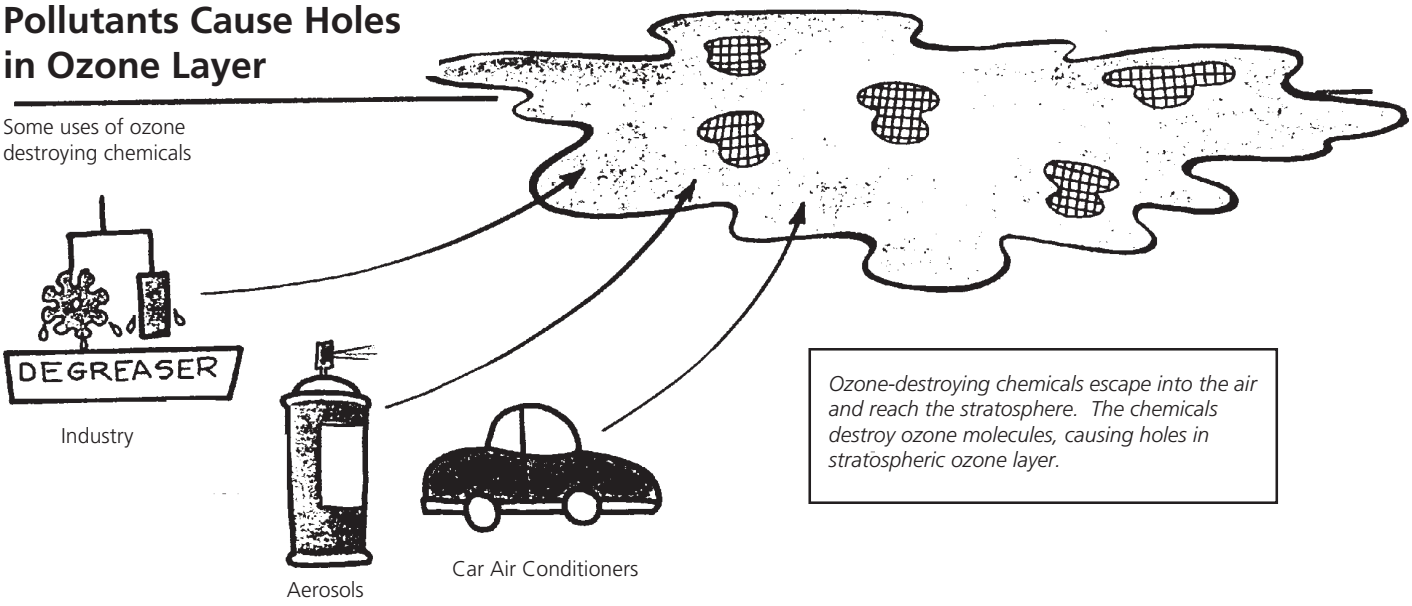
Ozone depletion is caused primarily by the use and release of chlorofluorocarbons (CFCs) into the air. CFCs are chemicals used primarily as propellants and refrigerants in appliances such as refrigerators, air conditioners, freezers, and industrial refrigeration units. These chemicals migrate into the stratosphere where they destroy ozone molecules, causing holes in the ozone layer. Current releases of CFCs will continue to destroy the ozone layer long after they are no longer used since it takes many years for these chemicals to migrate into the stratosphere.



When the ozone layer is damaged, there is an increase in harmful rays from the sun reaching the Earth. These rays can harm both human health and the environment.

Source: U.S. EPA, The Plain English Guide to the Clean Air Act, 1993.

Worksheet #1 continued



Source: U.S. EPA, The Plain English Guide to the Clean Air Act, 1993

In response to this serious problem, U.S. Congress passed a law to phase-out the manufacture of CFCs. These chemicals have already been banned from many products that once contained them or produced them, such as spray deodorants, styrofoam, and air fresheners. Other ozone-destroying chemicals are also targeted for reduction under the federal Clean Air Act Amendments passed by Congress in 1990. The act requires CFCs, which were previously released directly into the air when air conditioners and appliances were serviced or disposed, to be recovered and recycled.

The total amount of all CFCs and other ozone depleting chemicals released in Kentucky cannot be determined because there are many different sources, most of which are not required to report releases. However, reporting required for some industries reveals steady reductions in the release of CFCs in Kentucky as can be seen in Figure 2.

The federal government will ban CFC production by the year 2000. However, there is concern that some of the reductions in CFCs may be offset by the use of chemical substitutes that may also destroy ozone.

Worksheet #1 continued

Figure 2

Chlorofluorocarbon (CFC) Releases From Selected Industrial Sources In Kentucky (pounds)

Company	County	1987	1988	1989	1990
General Electric	Jefferson	211,000	176,850	227,000	100,877
General Electric	Allen	156,400	NR	NR	NR
Premium Allied Tool Inc.	Daviess	NR	76,622	89,259	61,062
Hitachi Auto Products	Mercer	30,307	56,589	42,575	31,084
Lexmark/IBM	Fayette	66,270	100,387	40,306	22,164
Eaton Corp.	Warren	24,000	90,000	NR	NR
Potter and Brumfield	Simpson	1,500*	61,015	56,659	30,220
Vermont American Corp.	Hardin	NR	750	750	40,300
Gates Rubber Polyflex	Hardin	NR	13,500	24,000	20,000
Holley Replacement Parts	Warren	NR	12,406	20,882	10,094
Ken-Tron	Daviess	11,480	14,490	11,040	9,220
GTE Valenite	Hopkins	13,986	18,066	11,028	NR
Therm-o-Disc	Laurel	11,730	22,289	14,527	NR
Total	**10**	**526,673**	**642,964**	**538,026**	**325,001**

NR—none reported

**1987 emissions data were reported for the facility located in Crittenden County, 1988–90 were from the Simpson County facility.*

Source: Kentucky Department for Environmental Protection Toxic Chemical Release Inventory Data, 1991

Worksheet #1 continued

Calculating Your "Contribution" to Global Climate Change

We usually do not think turning on a light or blow drying our hair contributes to the problem of global warming. The increasing use of energy in the world is considered a major factor in the increase of average global temperatures. Each energy source produces different amounts of carbon dioxide (CO_2), the major greenhouse gas. One source is electricity produced by coal burning power plants. Virtually all homes in Kentucky use electricity generated by these plants. This worksheet can be used to analyze the release of carbon dioxide resulting from the use of electricity in your home. It is important to note this estimate does not include CO_2 released while you drive your car and the many other day-to-day activities that require energy resources.

Calculate	**Total**
1. Total kilowatt hours used for one week in your home. Locate your electric meter. Record the total kilowatts at the beginning of the week (Monday morning before you go to school). Record the kilowatts the following Monday. Subtract the two amounts to determine the total kilowatts used in your home during one week.	_____
2. Your daily kilowatt usage. Divide your total in #1 by 7 days to calculate your average daily use.	_____
3. Total kilowatt hour usage for the year based on your daily average. Multiply your daily killowatt usage by 365 days to determine your average yearly use.	_____
4. The amount of carbon dioxide produced per year as a result of the use of electricity in your home. Multiply 2.5 lbs (the approximate amount of carbon dioxide released per kilowatt hour) times the number of kilowatt hours determined in #3.	_____
5. The yearly cost of the electricity your family consumes. Contact your electric company to determine the cost per kilowatt hour. Multiply kilowatt cost by the total kilowatt hours used for the year in #3.	_____
6. Approximately 25% of the energy we use is wasted. How much money would your family save if you cut electric use in your home 25%?	_____
7. How many pounds of carbon dioxide emissions could be reduced annually by your family if you cut your electricity consumption 25%?	_____

Worksheet #1 continued

Questions

1. Kentucky's estimated population is 3.7 million people. Assume four people live in each home in Kentucky, for a total of 925,000 homes. Assume each of those homes uses the same amount of electricity and produces the same amount of carbon dioxide that you calculated as your family's contribution to global climate change. What would be the estimated total amount of carbon dioxide Kentucky homes contribute to the global warming problem related to the use of electricity?
2. Using Figure 2 and a sheet of graph paper or a computer:
   A. Plot the total CFC releases for the years 1987 through 1990 (in blue ink).
   B. Plot the CFC releases for the facilities in the county nearest your school on the same graph (in red ink). Assume values for missing data by using the company's lowest amount in years they did report releases.

Note: Use as much of the space on the graph as possible. Empty space in graphing is useless and tiny graphs tucked in a corner are difficult to read. A proper graph must in symbols, lines and colors, and properly labeled axes. In this calculation you will need to use two vertical axes. Show and label all work including an explanation for each value.

3. Calculate the percent of change in the total CFC releases between 1987 and 1990 for the industries listed in Figure 2. Indicate whether there is a noticeable "trend" and why this may be the case.
4. In a paragraph, describe the relationship between greenhouse gases, CFCs, and global climate change.
5. What steps would you take if you wanted to reduce your contribution to global warming?

What you Can Do...

1. Compare the operating cost of different models and brands when your family purchases an appliance. "Saving" a few hundred dollars on a less energy-efficient appliances on sale may cost more in the long run in higher energy costs.

2. Plant Γ Z Ξ ς to absorb air pollution.

3. Encourage your electric company to participate in the Green Lights program - a national program to promote energy conservation. Find out more about the program by contacting the Green Lights Program, U.S. Environmental Protection Agency, 401 M Street S.W. 6202J, Washington, D.C. 20460, 202-775-6650.
4. Develop a strategy to reduce energy use in your home and school.
5. Consume less-enjoy more!!!

Activity 5. Radon Gas: The Hidden Risk

Instruction Sheet

DO YOU KNOW. . .

- What radon gas is and how it affects you?
- Whether radon gas is a problem in your home and school?
- What you can do to protect yourself from radon gas exposure?

Radon Gas, a Threat in Most Areas of Kentucky

Radon gas is a colorless, odorless gas that occurs naturally in the environment in rocks and soils. Radon is known to cause cancer and other health problems in human beings when it seeps into buildings through cracks and is trapped inside. Radon gas is a relatively unknown problem to many people, especially in Kentucky, but it can be a serious health threat.

A national radon survey, which included Kentucky, showed that homes in several regions of the state have radon gas concentrations above levels considered safe. It is important for all homes and buildings in Kentucky to be tested for radon gas problems. Action should be taken to reduce high levels of this air pollutant when it is found.

Purpose:

This activity will help you understand radon gas issues and problems in Kentucky and in your region. You will also have an opportunity to organize a radon testing project for your school and home.

Procedure:

Part I - Radon Gas in Kentucky: Problems and Needs

1. Obtain Student Sheet #1 from your teacher. Review, discuss, and answer questions.

Part I - Is Radon a Problem in Your Home or School?

1. Conduct a radon gas test for your home or school using commercially available radon detectors. Civic groups and others often provide free or reduced cost detectors for schools or will donate money for testing. Your school may be willing to pay for radon detectors used for on-campus testing.
2. Prepare a display comparing the results of radon testing in your home or school to the average level shown for your region. Discuss the possible reasons for differences that are discovered in the results.

Part III - Educating Others About Radon Gas

1. Create an educational project to teach others in your school and community about radon gas and its problems. Include information about levels found in your community.

Other Activities:

1. Research how certain geological characteristics in your area contribute to radon gas problems. A good source of information is the U.S. Geological Survey, 228 Mining and Mineral Resources Bldg., UK, Lexington, KY 40506-0107, 606-257-5500, or call your local U. S. Soil and Conservation Service Office listed in your telephone book under U.S. Government offices. Relate this information to the radon gas problem in your region of the state.

References/Additional Resources:

1. Kentucky Department for Health Services, Radiation Control Branch, 275 East Main St., Frankfort, KY 40601, 502-564-3700, provides information on radon gas in Kentucky and the steps necessary to reduce exposure. The department can also provide information on how to get radon gas test kits.
2. Your local health department also has information regarding radon gas and how to get radon gas test kits. Your local health department is listed in the telephone book under county offices.

Activity 5. Radon Gas: The Hidden Risk

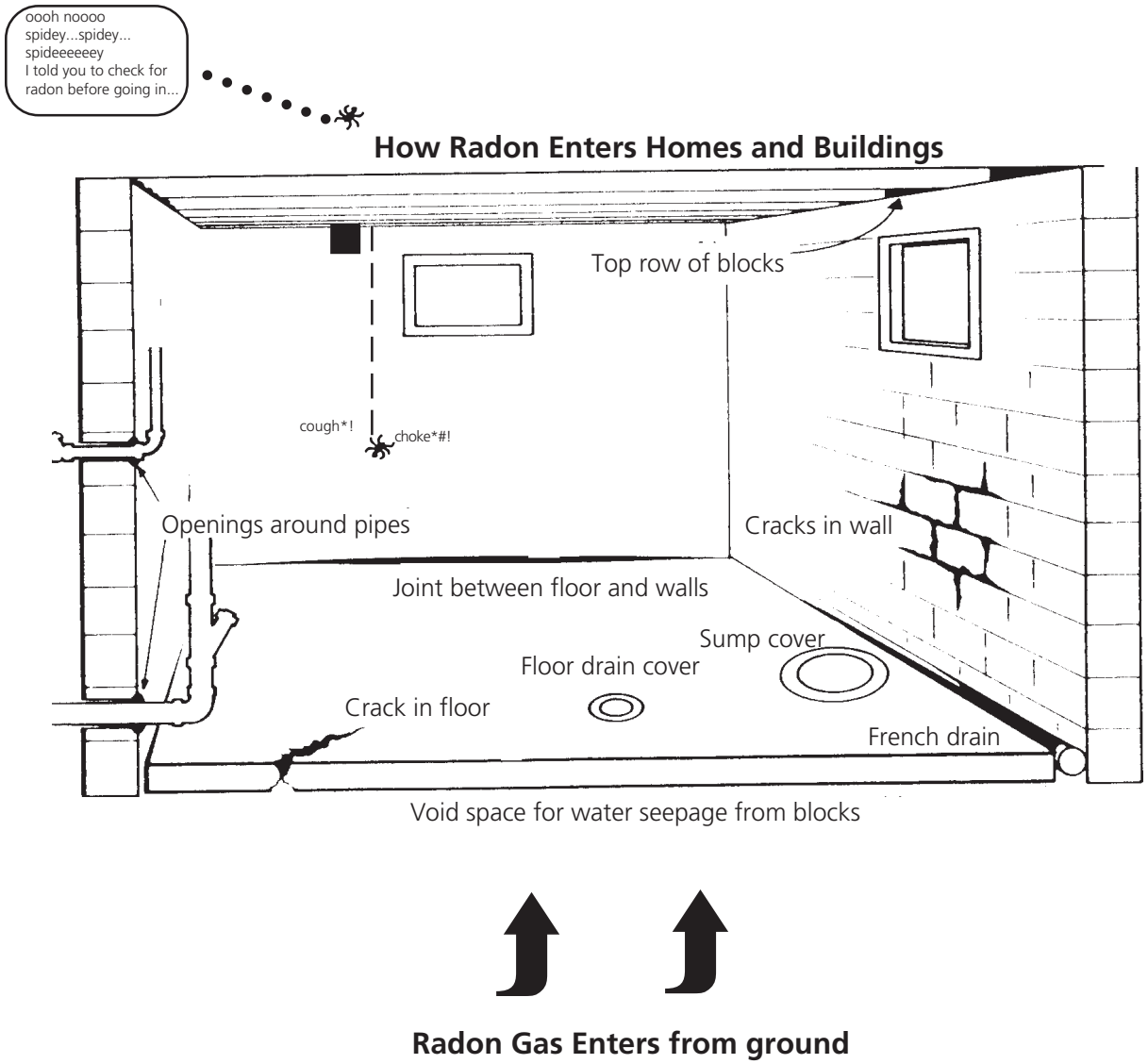
Worksheet #1

Radon Testing In Kentucky Shows Problems Statewide

Mr. and Mrs. Daniel James of Franklin County were shocked to learn that their home had dangerous levels of radon, a gas that they had never heard of before they were asked to participate in a national testing project. When their sample results came back from the laboratory, they were advised to do more testing and to take immediate steps to reduce their exposure. Their home, like many in Kentucky, was very vulnerable to radon gas problems.

Radon is a colorless, odorless gas that occurs naturally in the environment in rocks and soils. Radon gas becomes an indoor air pollutant when it enters buildings through cracks in foundations and basements and becomes trapped, as was the case at the James' home. It is also found in building materials and well water, and is most acute in areas with poor ventilation.

In 1987, the federal government conducted a radon gas survey in Kentucky. Radon gas levels were measured in 876 randomly chosen homes, including the James' home. The results showed that homes in several regions of the state had concentrations above levels considered safe (Figure 1 and 2). Statewide, 17% of homes tested had radon gas levels that exceeded the limits established to protect public health.



Worksheet #1 continued

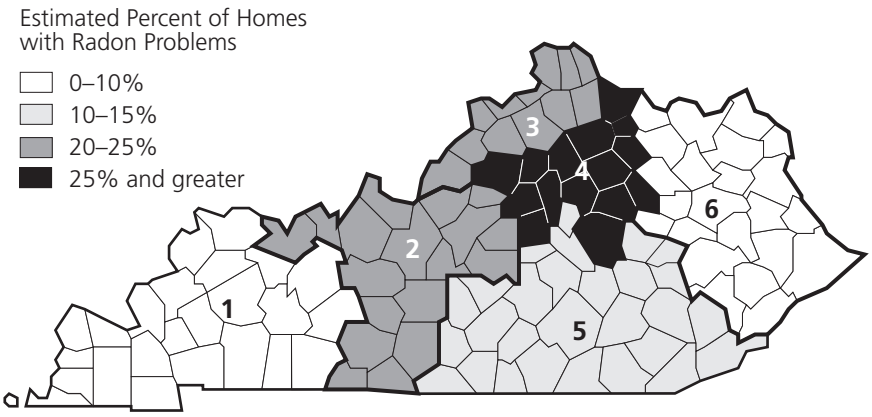
In the United States, 82% of the population's radiation exposure comes from natural sources. Fifty–five percent of this is contributed by radon gas. The importance of radon gas as a significant source of human radiation exposure has only recently been recognized. High levels of radon gas can cause lung cancer and may be responsible for 4,000 to 10,000 deaths each year. Figure 3 compares exposure to radon gas to other activities that have adverse health affects.

Radon Gas Levels Much Higher in Some Areas than Others, Testing Recommended

Some areas of the state had a significantly higher percentage of homes with unsafe radon gas levels due to the area's geological characteristics which are associated with naturally occurring radium and uranium. The level of radon gas in homes and buildings is highly variable even within the same region as a result of many factors, including building construction styles, ventilation, and the concentration of radon in soils.

The energy "crisis" of the 1970's made caulking and weather-stripping our homes popular to help conserve fuel. However, we did not know that preventing energy from escaping could potentially trap radon gas inside. Fortunately, unlike most environmental problems, radon gas is easy to test for and is relatively inexpensive to address. The key is to first identify the problem and then take measures to prevent radon gas from seeping into your home which may include sealing cracks or using a fan to disperse the gas.

Figure 1 **Radon Gas Levels by Regions**



Measurements of Households Surveyed

Region	Households Tested	% Households 0–4.0 pCi/L	% Households 4.1–20.0 pCi/L	% Households above 20 pCi/L
1	168	2.2	2.2	0.0
2	153	21.7	17.7	4.0
3	207	20.7	19.4	1.3
4	143	34.6	32.6	1.9
5	102	14.9	12.8	2.1
6	106	6.2	6.2	0.0
Statewide	879	17.1	15.6	1.5

pCi/L stands for Pico Curies per liter of air. This measurement is used to determine radioactive levels.
Source: Kentucky Cabinet for Human Resources, 1991

Worksheet #1 continued

Figure 2
Kentucky Counties with Highest Recorded Radon Levels in Homes

County	Radon level recorded (pCi/L)
Bullitt	66
Warren	32
Bourbon	31
Scott	29
Warren	28
Warren	27
Hart	25
Jefferson	25
Bullitt	24
Cumberland	23

Note: These single measurements may not be representative of all homes in these counties. Adverse health effects may occur from radon exposure above 4 pCi/L

Source: Kentucky Cabinet for Human Resources, 1991

Figure 3
Radon Risks

Annual Radon Level	If 100 people in a community were exposed to this level	This risk compares to:
100 p/Ci/L	About 35 people in the community may die from radon gas	Having 2000 chest x-rays/year
40 p/Ci/L	About 17 people in the community may die from radon gas	Smoking 2 packs of cigarettes/day
20 p/Ci/L	About 9 people in the community may die from radon gas	Smoking 1 pack of cigarettes/day
10 p/Ci/L	About 5 people in the community may die from radon gas	500 chest x-rays/year
4 p/Ci/L	About 2 people in the community may die from radon gas	Smoking half a pack of cigarettes/day
2 p/Ci/L	About 1 person in the community may die from radon gas	Having 100 chest x-rays/year

Source: U.S. Environmental Protection Agency

Questions?

1. In which region of the state would you be most concerned about radon gas exposure? The least concerned?
2. What percent of homes are likely to have radon gas problems in your county based on Figure 1?
3. Based on all the information you have reviewed, would you expect your home to have a radon gas problem? Explain your reasoning.
4. Is radon gas a greater threat today than 20 and 30 years ago? Why?
5. What steps can you take to reduce your exposure to radon gas?

What You Can Do...

1. Have your home tested for radon gas.
2. Organize a school campaign to educate your schoolmates about radon gas in your area.